Removal of Instrumental Background in the SNO Data

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Neutrino interactions and radioactive backgrounds in the SNO detector generate Čerenkov light that are detected by the photomultiplier tube (PMT) array. During the commissioning phase of the detector, other sources of instrumental background were observed. Some of these instrumental backgrounds generate signal that are similar in characteristics to Čerenkov light, while some show more distinctive behavior. In this article, a brief description of these instrumental backgrounds and the principles behind the data cuts that were developed to remove these backgrounds are given.

The "flashers" are the most dominant instrumental background in the SNO detector. These are events in which light is emitted by a PMT. The exact cause for this light emission is unknown, but this type of background has been seen at other neutrino detectors. The flashers can be easily discriminated from Čerenkov light by the PMT hit timing. The flashing PMT generates an early trigger, and its flashing light is observed across the detector ~70 ns later. In addition, four or more electronic channels surrounding the flashing PMT channel usually show pickup signals, which further distinguishes the flashers from Čerenkov light.

In another class of instrumental light, bursts of light are observed to originate from the neck region of the detector. These events may arise from static discharge of the insulating materials in the D_2O water system. Most of the PMT hits occur near the south pole of the detector in these events. In many of these neck events, the outward-looking (OWL) PMT's, which are used to form the cosmic veto trigger, would detect the stray light. Four PMT's were installed in the neck region to enhance the efficiency of tagging this neck light.

Electronic-related instrumental backgrounds do not generate any light-like signal in the detector. The most common pathologies observed in these events include a flat timing spectrum (TAC) of the hit channels, multi-channel or multi-board electronic pickup, and near-pedestal charge distribution for the hit channels. In all of these cases, the event characteristics are so distinctive from the Čerenkov light that they can be easily removed by the differences in the charge and timing distributions of the fired channels.

We have developed one of the two independent data reduction schemes used in SNO analysis. Figure 1 shows the progression of instrumental cuts over a subset of neutrino run data. An event-by-event comparison of the two reduced neutrino data sets shows a significant overlap of events in the solar neutrino energy regime. Two calibration sources (^{16}N and ^{8}Li) have been used in understanding the accidental removal of physics events by these data cuts. Our studies of this physics "sacrifice" indicate that less than 1% of the physics events originated from the D_2O are removed by the data reduction schemes.

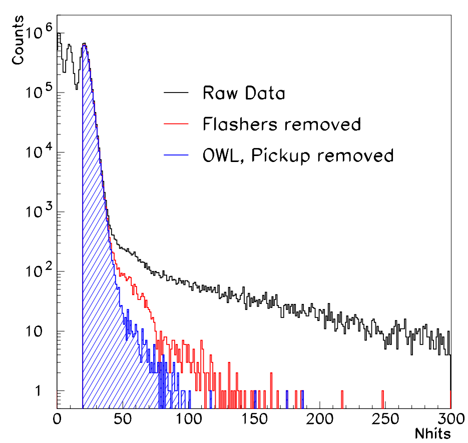

Figure 1: Progression of instrumental cuts.